# Pennsylvania Tunnel and Terminal Railroad Company

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## General Description of New York Terminal

with reference in more detail

to

## East River Tunnels.

November, 1908.

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# PENNSYLVANIA TUNNEL & TERMINAL RAILROAD COMPANY.

## New York Terminal of Pennsylvania Railroad and Long Island Railroad.

### GENERAL DESCRIPTION OF TERMINAL SYSTEM.

The lines of the Company extend as a double track railroad from the point of divergence from the present main line of the Pennsylvania Railroad near Harrison, N. J., across Hackensack Meadows to the west face of Bergen Hill on an embankment with overhead crossings of all existing lines, thence in two single track tunnels under Bergen Hill, through a permanent shaft a short distance west of North River and thence under the North River and 32nd Street, Manhattan, to the west end of the New York Station at Tenth Avenue. The station area extends eastward to about 300 feet east of Seventh Avenue. The main portion of this area, from Ninth Avenue to Seventh Avenue, is two city blocks in width, from 31st Street to 33rd Street, is two blocks long and will have 21 parallel tracks with suitable crossings and connections. The station building will cover the east half from Seventh Avenue to Eighth Avenue, and the new Post Office will be built immediately west of Eighth Avenue over a part of the west half.

Easterly from Seventh Avenue the tracks converge into three tracks under 32nd Street and the same number under 33rd Street which extend short distances in three track tunnels under these streets. Near Sixth Avenue the three tracks converge into two which are continued in single track tunnels, two under each street, to Second Avenue where they curve to the left and enter permanent shafts a few feet east of First Avenue.

Continuing eastward from these shafts, the four tracks, each in a single tunnel, pass under East River, through two permanent shafts near the bulkhead line in Long Island City just west of Front Street, and reach the portals between Van Alst Avenue and Thomson Avenue. Thence they pass through the so-called Sunnyside Yard which may be considered as ending at Woodside Avenue.

The lengths of some of these sub-divisions vary slightly on the different lines, but the averages are as follows:

| | | |
|---|---|---|
| West of Bergen Hill on Embankment and bridges | 34,400 | feet |
| Under Bergen Hill to Weehawken Shaft, tunnels.. | 5,986 | " |
| Weehawken Shaft to Tenth Avenue, tunnels...... | 7,406 | " |
| New York Station.............................. | 2,985 | " |
| Three-track and single track tunnels to First Avenue Shafts ......................... | 5,199 | " |
| Tunnels from First Avenue Shafts to Front Street Shafts in L. I. City..................... | 3,948 | " |
| Tunnels from Front Street to portals........... | 3,848 | " |
| Sunnyside Yard ................................ | 10,284 | " |
| Total (including Shafts)................ | 74,056 | " |
| | or 14 miles. | |

## THE EAST RIVER TUNNELS.

### From First Avenue to Front Street Shafts.

The shafts were sunk as steel caissons, each crossing two tunnel lines. Openings were formed in the sides of the caissons for the tunnels to pass through; these were closed temporarily while sinking the caissons. On the Manhattan side of the river it was found unnecessary to sink the caissons to full depth, rock of satisfactory character having been found above tunnel level; the sinking was therefore stopped, the openings for the tunnels closed solidly with concrete and the excavation of the shafts continued to the required depth by open excavation. On the Long Island side the caissons were sunk, with use of compressed air, to the full depth of the shafts.

For convenient reference the lines are designated A, B, C and D, from north to south, A and B being continuations of 33rd Street lines and C and D continuations of 32nd Street lines.

The tunnels were driven with shields, in compressed air. Each tunnel is 23 feet exterior diameter and has a cast iron shell weighing 9,100 lbs. per lineal foot, built in rings 2 ft. 6 in. wide. The thickness of the metal at the centre of the castings is 1½ inches, increasing to 2⅜ inches at the root of the flanges which are 11 inches deep. The tunnel has a heavy concrete lining, the arch being nominally 2 feet thick from the outside of the cast iron to the interior face of the concrete. The lower portion of the finished tunnel is trough-shaped, the width of the trough being about one foot greater than an ordinary Pullman car; this feature was devised by the late Mr. A. J. Cassatt, President of the Pennsylvania Railroad, and is expected to reduce risk in case of derailment. Ducts for electric cables are built into the side walls of the trough, each tunnel having 15 ducts for high tension wires and 40 ducts for low tension wires.

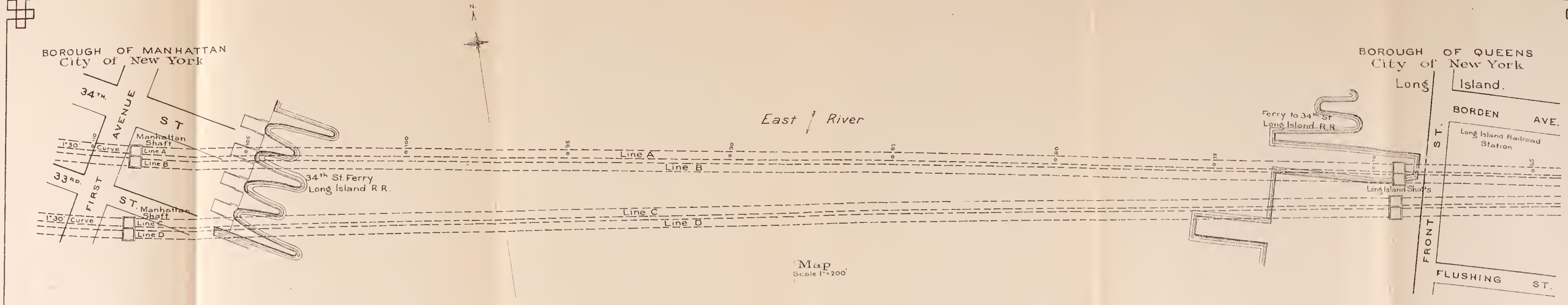
Going eastward from Manhattan the tunnels have a descending grade of 1.5% to the lowest point about 1,000 feet from the First Avenue Shafts, the first 300 feet being on curves of 1° 30′, —thence eastward the lines are tangents to points east of Front Street. From the low points the lines have an ascending grade of 0.7% to the established bulkhead line, about 600 feet from the Front Street Shafts: from the bulkhead line the ascending grade is 1.22 to 1.26% in lines A, B and D and 1.9% in line C, the steeper grade being required to permit a crossing over line B which occurs farther east.

The tunnels were driven from both ends, the four tunnels requiring eight shields. Each shield with its machinery weighed about 270 tons and was moved by 27 hydraulic jacks, each 9 inches in diameter and 33 inches stroke. A push of 5,600 tons has been applied to a shield but under ordinary circumstances 3,000 to 4,000 tons were sufficient. The capacity of the compressed air plant was 80,000 cubic feet of free air per minute. This was sufficient for the supply of all headings, ten in number (two east of Front Street) except on a few occasions in the earlier part of the work. The escape of air was reduced and the work of tunneling much facilitated by the use of a heavy clay blanket on the river bed over the tunnel lines. The lowest points of the tunnels were 91.4 feet below mean high tide, corresponding to an air pressure of 40.6 lbs. per square inch but in driving tunnels an air pressure balancing the water pressure at the tunnel axis was usually sufficient.

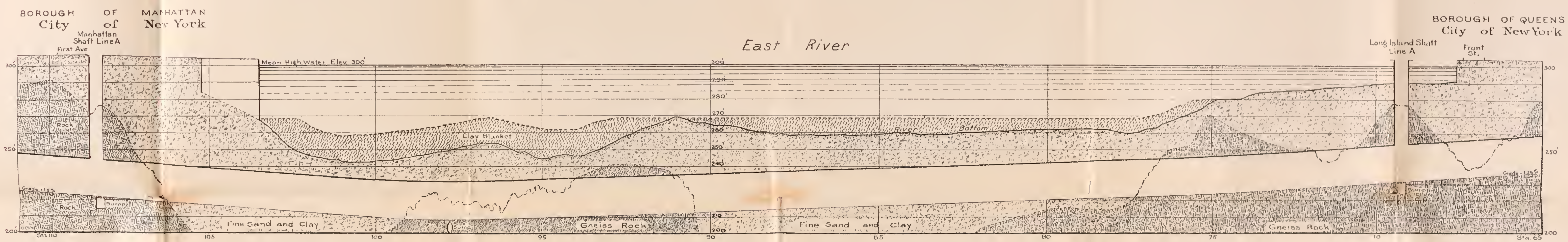
The headings from the opposite sides of the river met in February and March, 1908, at the east face of the reef which extends downstream from Blackwell's Island, with an average discrepancy of 0′.021 in alignment and 0.′025 in levels with maxima of 0′.03 and 0′.034. The discrepancy in the distance across the river, compared with the distance computed from the triangulations has not yet been ascertained precisely but is about 0′.07.

The aggregate length of the four tunnels between shafts is 15,668 feet, an average of 3,917 feet for each. For nearly one-half the distance the tunnel is wholly or partly in rock in which the daily progress was 2 to 4 feet in each heading; in the remaining distance in earth, much of it quicksand, the daily rate increased from about one foot per day in the beginning to an average of 9 or 10 feet towards the close.

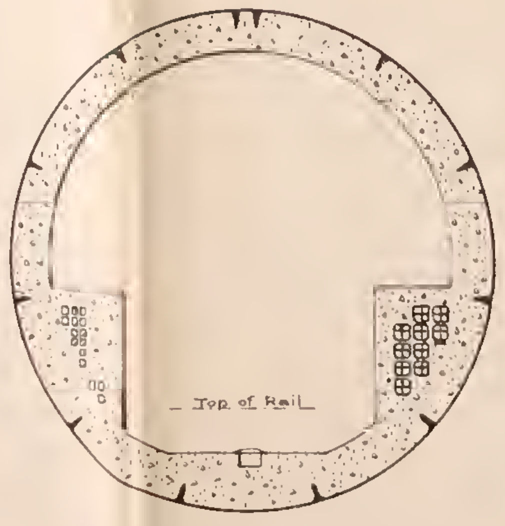
The iron lined tunnels extend eastward from the Front Street Shafts about 1,980 feet, the aggregate length of iron-lined tunnels east of First Avenue being 23,592 feet. These tunnels, as well as the permanent shafts, were built by S. Pearson & Son, Inc. as contractors.



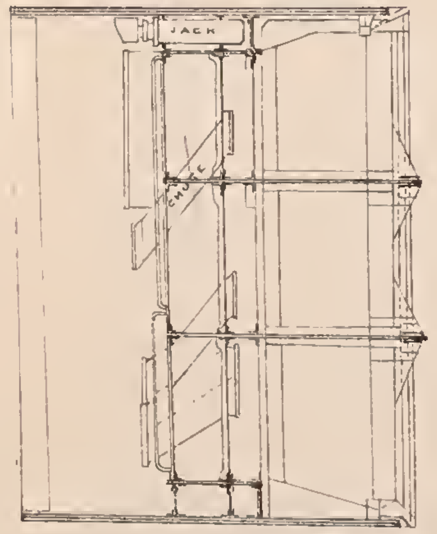
Map
Scale 1"=200'



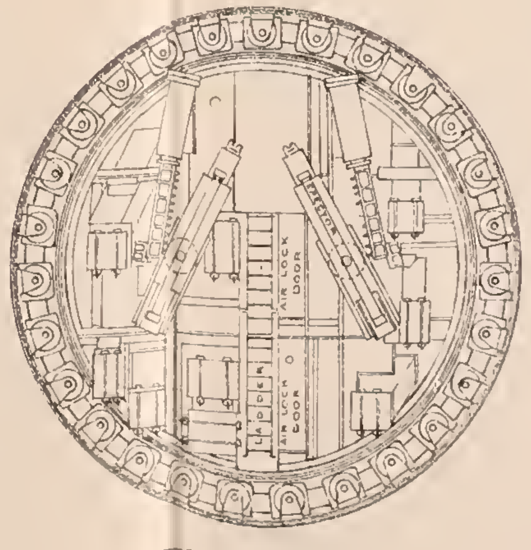
Profile of Line A
Hor Scale 1"=200', Ver 1"=40'



Cross Section of Tunnel
Scale 1/8"=1'-0"



Vertical Section of Shield
Scale 1/8"=1'-0"



Rear Elevation of Shield
Scale 1/8"=1'-0"

Pennsylvania Tunnel and Terminal Railroad Company

## East River Tunnels

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